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SOLDIER AWARENESS OF THE THREAT FROM DIRECTED ENERGY

George Mastroianni
and
Bruce Stuck

DIVISION OF OCULAR HAZARDS

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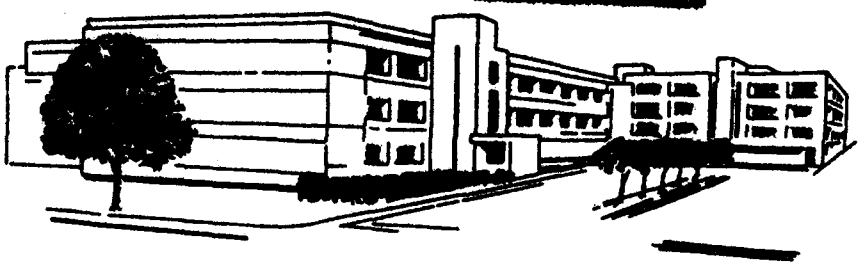

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To help define the present site of soldier knowledge about DE, LAIR has cooperated with the TRADOC Analysis Command- White Sand Missile Range (TRAC-WSMR) to produce a paper and pencil survey which can be administered to troops to assess their knowledge of basic DE characteristics and hazards. TRAC-WSMR has conducted a large-scale, comprehensive survey of a broad spectrum of soldiers serving worldwide. A detailed analysis of these results is being prepared for the combined Arms Training Activity, Ft. Leavenworth, Kansas. LAIR plans to administer the survey to a series of smaller, more specialized groups. Accurately characterizing the current state of awareness in the area will best be accomplished securing the largest possible number and variety of responses.

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ABSTRACT

Ten intelligence specialists responded to a survey concerning basic knowledge of directed energy (DE) weapons, countermeasures, and characteristics. The responses indicated sophisticated understanding of the DE threat in some areas, but significant weaknesses in others. In particular, understanding of the dimensions and ranges of current lasers was poor, as was knowledge of laser injury symptomatology and first aid procedures. The results suggest specific areas for training development effort in the future.

INTRODUCTION

Growing recognition of the potential importance of directed energy (DE) weapon systems, guidance systems, rangefinders, designators, training devices and simulators, and other military DE applications on the battlefield has led to a strong military interest in protecting the individual from the health hazards associated with these systems. The Medical Research and Development Command (MRDC), primarily through Letterman Army Institute of Research (LAIR) and the United States Army Medical Materiel Development Agency (USAMMDA), has played a leading role in research directed toward identifying the vulnerability of military personnel to laser (a particular form of DE) radiation, and in developing interim and long-term solutions to the problem of protecting personnel from this threat.

Adequate protection from the laser threat will depend not only on developing specific items of hardware for issue to military personnel, such as laser-protective spectacles or goggles, but also educating and training the force about the laser threat. Because laser technology is constantly being assimilated into the weapons inventory in novel applications, training programs will require continuous modification to ensure that military personnel are armed with the most up-to-date knowledge concerning the threats they face, and the efficacy of the protection they possess.

The first step in developing any training program is, of course, determining the current state of knowledge in the target audience. To establish a current profile of individual familiarity with DE, LAIR has cooperated with the TRADOC Analysis Command - White Sands Missile Range (TRAC-WSMR) to produce a paper and pencil survey which can be administered to troops to assess their knowledge of basic DE characteristics and hazards. TRAC-WSMR has conducted a large-scale, comprehensive survey of a broad spectrum of soldiers serving worldwide. A detailed analysis of these results is being prepared for the Combined Arms Training Activity, Ft. Leavenworth, Kansas. LAIR plans to administer the survey to a series of smaller, specialized groups. Accurately characterizing the current state of awareness in this area will best be accomplished by securing the largest possible number and variety of soldier responses. The results can then be used to develop appropriate training programs.

METHOD

The purpose of this technical note is twofold. First, we present an interesting "snapshot" of the DE awareness of a small group of highly trained intelligence specialists. Second, we have reproduced the survey we used in Appendix A so that others may use it to expand the data base on individual awareness of the DE threat. Appendix B contains some valuable references on the techniques of questionnaire administration. Appendix C contains the nominally "correct" alternatives for each question, with discussion where necessary.

The survey instrument we used is reproduced at Appendix A, the **Directed Energy Cognizance Survey**. While the survey covers all forms of DE, including microwave, radio-frequency and laser radiation, LAIR's primary interest is in the items pertaining to lasers. This survey was not intended to be a comprehensive evaluation of DE knowledge, but rather a quick indicator of DE awareness. Military personnel are expected to complete the questionnaire in 10-15 minutes.

The sample of responses reported here was obtained from a group of ten intelligence specialists, both officer and enlisted, who are specially trained in the appearance and capabilities of threat equipment and doctrine. These soldiers receive special training in the employment of optical devices for surveillance and observation. The responses of this group probably represent a "best-case" scenario compared to results that might be expected Army-wide. For these reasons, we think it would be profitable to point out strengths and weaknesses in DE knowledge that can be inferred from the survey responses from these specialists.

RESULTS

TABLE 1

Item	Subject	# "Correct"	# "Wrong"
1	Definition of lasers	10	0
2	Common military lasers	10	0
3	Vulnerability to lasers	10	0
4	Can lasers blind?	10	0
14	Do sunglasses protect from lasers?	10	0
31	Specular reflections dangerous?	9	1

In general, the results indicate that these people are aware that lasers are a threat (Items 1 and 2), and that both eyes and optical devices are susceptible to damage (Items 3 and 4). Furthermore, they are aware that binoculars increase the risk of injury (Item 13), and that sunglasses afford little protection (Item 14).

TABLE 2

Item	Subject	# "Correct"	# "Wrong"
7	What are reflection hazards?	6	4
17	What will attenuate laser beam?	9	
30*	Reflection hazards from curved surface	6	4
34	Laser hazard range	7	1
35	Laser beam diameter	1	8

*Note - more or less than ten responses may be recorded because of soldiers selecting multiple responses or not answering particular items.

There is, however, a certain amount of confusion about how lasers are propagated and what factors enhance or ameliorate their destructive effect. In Item 7, for example, more soldiers identified snow (3) as a laser reflection hazard than painted metal (1); depending on the composition of the paint, reflection from such surfaces can be quite hazardous. Two of the respondees incorrectly selected "smoke" when asked to choose among four alternative obscurants (actually, three obscurants and darkness) that would not reduce vulnerability to lasers (Item 17). Smoke can, of course, be a very effective attenuator of laser light, as can fog and dust, depending on the nature of the obscurant and the character of the laser radiation. Nine soldiers did give the correct response, but this aspect might be a problem area in a less highly trained group.

The responses to Items 30 and 31 show that the soldiers generally recognize that reflection from a specular surface is more hazardous than reflection from an irregular one; nonetheless, half as many (3) soldiers selected the "incorrect" alternative in Item 30, (indicating a long-range hazard from non-specular reflections), as selected the correct alternative (indicating only a short-range hazard).

Items 34 and 35 show a disturbing uncertainty about the most basic aspects of the laser hazard. Fully half the respondees

thought that lasers could only be dangerous at ranges less than 5 km, even though lasers in common military use today can have a Nominal Ocular Hazard Distance (NOHD) well in excess of this figure, especially if optics are used. Moreover, high-energy lasers, if used as weapons, could pose a personnel hazard at considerable distances.

Nearly half the respondees thought that a laser beam is only 1 mm in size 2 km from the source; 2 thought it is 10 cm, 2 thought it 10 m and only one chose 1.5 m, which is probably the best choice given. This lack of knowledge about the size of the beam could have important implications for the judgments of risk military personnel might make in certain situations. Especially among soldiers who have detailed knowledge of the pointing and tracking capabilities of existing systems, these errors in estimating the size of the beam could be important: how dangerous could a 1 mm beam be at 2 km given the aiming and tracking error inherent in even our stabilized systems?

TABLE 3

Item	Subject	# "Correct"	# "Wrong"
24	Symptoms of visible laser exposure	10	0
25	Actions after visible laser exposure	2	8
26	Actions after possible laser exposure	6	3
27	Actions after serious IR exposure	10	0
28	Actions after serious visible exposure	9	1
29	Duration of flash blindness	7	2

The responses to items 24-29 offer an important insight into responses to laser injury and should be of interest to the military medical community. In general, the responses suggest a tendency to seek medical help even in cases of mild or only suspected exposure.

Responses to Items 25, 27, and 28 clearly show that these soldiers would seek medical attention at the onset of symptoms that might result from a visible laser exposure causing retinal burns or hemorrhage, or from an infrared corneal lesion. Surprisingly, three soldiers said they would seek medical help immediately if they saw a flash of light that they thought might be a laser even if no symptoms were produced. Two more respondees indicated that they would continue the mission but seek medical help later. These results underscore the importance of dissemi-

nating sound medical training to the troops, and spelling out in detail when medical assistance is really needed if laser exposure occurs or is suspected. The disastrous effects of a flood of uninjured or only slightly injured personnel on already strained forward medical assets, such as the battalion aid station, division clearing station, and combat support hospitals, could pose a significant problem for planners of future tactical medical support.

DISCUSSION AND CONCLUSIONS

The results reported in this note represent a tiny sample of soldiers who do not represent the average servicemember (if such a concept has any meaning in a force as diverse as the U.S. Military). The conclusions drawn must clearly be regarded as preliminary, tentative, and at most suggestive of areas to concentrate future efforts. Despite these caveats, the information contained in these data does reflect the state of DE knowledge of a small, highly trained group of intelligence specialists. As such, it offers valuable insights into DE awareness that should contribute to the development of much needed DE training programs.

APPENDIX A

DIRECTED ENERGY COGNIZANCE SURVEY

1. What kind of directed energy is a beam of very intense light that may or may not be visible?

a. Particle beam.

b. High-power microwave.

10 c. Laser.

d. Not a kind of directed energy.

2. Which of the items listed below is a directed-energy device that you might encounter on the battlefield now?

10 a. Laser designator.

b. Particle beam weapon.

c. Phaser.

3. Which are most susceptible to damage from lasers?

a. Electronic devices.

10 b. Optical devices.

c. Mechanical devices.

4. Is the following statement true or false? Laser damage to the eye can produce permanent blindness.

10 a. True.

b. False.

5. Which of the medical effects listed below are produced by high power microwaves?

4 a. Damage to the cornea of the eye.

6 b. Damage to the retina of the eye.

c. Electric shock.

6. You notice a bright flash of green light. What should you do?

6 a. Take cover.

b. Look at the light to see where it came from.

c. Put on sunglasses and look for the light.

5 d. Put on BLPS and look for the light.

7. Which reflective surface listed below can enhance the risk from lasers?

6 a. Glass.

3 b. Snow.

1 c. Painted metal.

8. Which countermeasure listed below is NOT effective against radio frequency radiation?

a. Covers.

6 b. Smoke.

4 c. BLPS.

9. Which type of directed energy weapon would NOT disrupt electronic communications?

4 a. Particle beams.

1 b. Radio frequency.

5 c. Lasers.

10. Which of the following are medical effects of microwaves?

    a. Headaches.

3   b. Clouding of the eye lens.

    c. Fatigue.

    d. Nervous disorders.

7   e. All of the above.

11. During field exercises how should you hold binoculars that are not stowed or being used?

7   a. Vertically.

2   b. Horizontally.

    c. At eye level ready for use.

1   d. Shouldn't be used during field exercises.

12. Which of the following are major classes of directed energy systems? Choose all that apply.

9   a. Laser.

1   b. Ultrasound.

5   c. Radio frequency.

8   d. Particle beams.

2   e. Infrared .

13. What effect does the use of binoculars have on the amount of laser light that gets into the eye?

    a. Decreases the amount.

10 b. Increases the amount.

    c. Has no effect.

    d. Reflects the laser so none gets into the eye.

14. Under which condition can sunglasses completely protect your eyes from laser light?

    a. In bright sunlight.

    b. Night time.

    c. If very hazy.

10 d. Under no condition.

15. Microwaves belong to which class of directed energy?

9   a. Radio frequency.

    b. Particle beam.

    c. Lasers.

    d. Not a form of directed energy.

16. If you suspect a laser is being used you should:

    a. stare at the light until you are sure.

3   b. look away and don BLPS.

    c. use your binoculars to verify the source.

2   d. none of the above.

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17. Which of the following will not reduce the vulnerability from laser?

2 a. smoke.

1 b. fog.

1 c. dust.

9 d. night.

18. Besides being a hazard to vision lasers may also:

1 a. vaporize personnel instantly.

1 b. sterilize personnel.

1 c. stun personnel.

8 d. none of the above.

19. Which of the following is an effect of lasers on equipment?

a. burned or cracked lenses on optical devices.

b. burn spots appear on the video screen of a camera.

c. destruction of the detectors in a thermal sight.

10 d. all of the above.

20. High-power microwaves can:

a. disrupt communication.

b. cause some types of ammunition to detonate.

c. burn out components in computers.

5 d. A and C.

5 e. A, B, and C.

21. The currently fielded laser range finders and target designators are the greatest danger to which equipment/systems?

    a. communication.

10 b. optics.

    c. radars.

    d. ammunition.

22. The currently fielded radars (a form of radio frequency) are the greatest danger to which equipment/systems?

8 a. communications.

1 b. optics.

1 c. radars.

    d. ammunition.

23. Lasers might be used by the enemy in the following ways:

    a. man-portable.

    b. aircraft mounted.

    c. vehicular-mounted.

10 d. all of the above.

    e. none of the above.

24. If struck by a visible laser in the eye you may:

    a. experience flash blindness.

1 b. experience a minor burn inside your eye accompanied by little or no pain.

    c. experience dark spots or blind spots in vision.

1 d. not even know you've been injured.

8 e. any combination of the above.

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25. After experiencing a flash of red or greenish light, your buddy complains of blind spots in his vision, but little or no pain. You should:

    a. take no action, continue the mission.

2 b. continue the mission, seek medical help later.

    c. look away from the light, take cover, wait for vision to clear, continue mission.

8 d. seek medical help immediately.

26. After seeing a light that you think might be a laser, what should you do?

    a. take no action, continue the mission.

2 b. continue the mission, seek medical help later.

4 c. look away from light, take cover, wait for vision to clear, continue the mission.

3 d. seek medical help immediately.

27. Your buddy complains of severe eye pain and significant loss of vision; but did not experience any flashes of light, you should:

    a. take no action, continue the mission.

    b. continue the mission, seek medical help later.

    c. look away from light, take cover, wait for vision to clear, continue the mission.

10 d. seek medical help immediately.

28. After experiencing a flash of greenish or red light your buddy complains of large dark spots in his field of vision:

    a. take no action, continue the mission.

1 b. continue the mission, seek medical help later.

1 c. look away from light, take cover, wait for vision to clear, continue the mission.

8 d. seek medical help immediately.

29. Flash blindness will clear up usually:

7 a. in a few seconds to a few minutes.

2 b. after several hours.

c. after several days.

d. after a week.

30. The reflection of a laser beam from a curved surface is hazardous:

3 a. at long ranges up to 1200 meters.

6 b. within a few meters of the reflecting surfaces.

c. only if the beam is reflected upwards.

1 d. only at the source.

31. The reflection of a laser beam from a smooth, flat surface is:

a. hazardous at a few feet.

b. not hazardous.

9 c. as hazardous as the original laser beam.

1 d. twice as hazardous as the original laser beam.

32. The more sophisticated or advanced the electronics are in any system the more vulnerable they are to an RF attack.

8 a. True.

2 b. False.

33. All laser light that is harmful to the human eye is visible.

a. True.

10 b. False.

34. Lasers can be dangerous at a maximum range of:

a. 100 meters or less.

1 b. 100 meters to 1 kilometer.

4 c. 1 kilometer to 5 kilometers.

2 d. 5 kilometers to 10 kilometers.

2 e. 10 kilometers or greater.

35. The size of a laser beam at at range of 2 kilometers is:

4 a. 1 millimeter.

1 b. 1.5 meters.

2 c. 10 meters.

2 d. 10 centimeters.

e. 100 meters.

36. Lasers are only harmful if you look directly at them.

1 a. True.

8 b. False.

Appendix B

While the construction, administration, and analysis of questionnaire surveys is relatively easy, there are a number of common pitfalls for the inexperienced. Several excellent and accessible sources should be consulted if surveys are to be administered by people not specifically trained for this purpose. Where the administrator has biases or vested interests in the outcome of the survey, it is best to turn the job over to a disinterested party.

Good references:

1.Questionnaire Construction Manual. U.S. Army Research Institute for the Behavioral and Social Sciences (Ft. Hood Field Unit), July 1976. AD A037815

2.Questionnaire Construction Manual Annex. U.S. Army Research Institute for the Behavioral and Social Sciences (Ft. Hood Field Unit), July 1976. AD A043012

3.Subjective Evaluation Handbook. Air Force Operational Test and Evaluation Center, January 1984.